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Date: 20
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Nuclear Physics
7th Semester

Important Short Question
Long Question

Q-NO#1:-

Define Nuclear Spin.

Ans:-

In nuclear spin state can take any number, fraction or integer. the number is independent on the

Nuclear spin angular momentum is a quantized properties of the nucleus in each atom, it is assigned base on the properties of neutron and proton

Nuclei with even

All nuclei with even mass number have
I = 0, 1, 2, 3, 4,

Odd

All nuclei with odd mass no hav
I = 1/2, 3/2, 5/2

Unit:-

the SI unit of the spin is the same as classical angular momentum

- N.m.s
- J.s and
- Kg

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Q-NO # 02

Defin magnetic dipole moment

The magnetic moment is the magnetic strength and orientation of a magneti or other object that produced a magnetic field.

A current loop where the circulating current is I with area A enclosed by the current.

magnetic dipole moment

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NOTE:- current I circulate clockwise when looking along Un

SI unit :- magnetic moment is Am^2

Q-NO # 03

What is meant by Spin.

The quantity isospin can be represented by a set of operator which not only obey the same algebra as component of angular momentum.

But also in same way as angular momentum to we need an additional quantum to indicate wheather the Nucleon is proton or as ~~nuclear~~ nutron Due to its formula analogy with ordinary spin or isospin if we take it to be $\frac{1}{2}$ it 2 component will be represented by quantum no having the value $\frac{1}{2}$ and $-\frac{1}{2}$.

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Q-NO #04
write down the properties of (vi) Nuclear force.
↳ are short range forces

Ans:-

(i) Nuclear forces are attractive forces b/w
proton and nutron (p–n)
proton and proton (p–p)
nutron and nutron (n–n)

(ii) Nuclear forces are charge independent. It was found that nuclear force between two proton is the same as between a proton and a neitron

(iii) Nuclear force are the strongest in natur

(iv) Nuclear force are non conservative force.

(v) Nuclear force are not centeral force.

Q-NO #105
why do nuclei tends to have more nutron then proton at large mass no.

Answer:-

Nuclei tend to have more nutron then proton at large massnumber.

Reason:

At the number of proton increase in a nucleus, the Coulumbs repulsive force increases which tends to break the nucleus a part. So to keep the nucleus stable more of nutron are needed which are natural in nature.

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Q-NO #06

Describe the spin dependence of nuclear force.

The nuclear force has a spin dependent component. The force is stronger for the particles with their spin aligned then for those with there spin anti aligned.

Spin dependent of force is highly non Trival

Example:-

Expontional satarbility of some particular nuclear with nucleon number.

Q-NO #07

Why do nuclei undergo β decay.

Beta decay occurs when in a nucleous with too many proton or too many neutrons, One of the proton or neutrons is Transformed into the other.

In Beta minus decay or neutron decays in to the proton an electron and antineutron.

Beta decay occurs, when an atom has either too many proton or too neutron in it.

$$H_1^3 \longrightarrow He_2^3 + e_{-1}^0 + \bar{V}_0^0$$

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Q-NO#08

What is the size and mass of a nucleus.

The atom with the smallest mass is the hydrogen atom, its mass is about (10^{-27} kg). The masses of the other atoms go up to about 200 times this.

The nucleus of an atom is about 10^{-15} m in size.

This means it is about 10^{-15} or (1/ 100,000) of the size of the whole atom. The nuclei of some atom are spherical, while others are stretched or flattened into deformed shape.

The average radius of nucleus with A nucleon is

$$R = R_o A^{1/3}$$

where

$$R_o = 1.2 \times 10^{-15} m.$$

Q-NO #09

What is meant by the Alpha particles? On what factors it depend upon.

Alpha particle are composite particles consisting of two protons and two neutrons tightly bound togather.

Alpha particles depend upon:-

Alpha particles depends only on its initial energy and average energy loss rate in the medium.

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For Alipha particles of the same energy The (Average) range is quite consistent from One particle to the next.

Q-NO # 10

Write down the properties of Alpha particle.

Answer:-

There are following properties of Alpha particle.

(i) Alpha particles are He^4 nuclei and 2 units of positive charge and 4 times the mass of the hydrogen nucleus.

(ii) Being charged particle, They are deflected by electromagnetic field.

(iii) They ionize of medium they pass through. Their ionization power is for superior to that of the Beta and gema particles.

(iv) The speed of alpha particles is of the order of 107 m/s

(v) They are 8000 time heavier than beta particles.

They have short range in air. (few cm)

Q-NO # 11

Why neutron no tends to exceed proton number in stable nuclei.

Answer

As is known, proton are positive charged ions and repel each other electrically. In nuclei with more than 10 protons or so, the force of repulsion became to large

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Therefore excess of neutron is required for stability. This because neutron produced only attractive force amongest them.

Q-NO#12

Why are neutrons more stable in nucleus.

Answer:-

The neutron is an intermediary between the protons as the discrete force of the proton are otherwise incomplete/ incompatible.

This bond also give a full complement of discrete force to the neutron.

Hence its stability with in the nucleus.

Q-NO#13

Write down some achievement of Shell model.

Answer:-

(i) It is explains magic Numbers.
(ii) It explains the magnetic moment of some nuclei nicely
(iii) It explains successfully the ground state spin
(iv) It explains the greatly stability and highly binding energy
(v) It explain the phenomenon of nuclear isomerism.

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Q-NO #14

Define Binding energy. draw the binding energy per nucleon curve as a function of mass number.

Answer:-

A nucleus is stable due to strong nuclear force. The nuclear force bonds all the nucleus in very small volume. The Total energy required to break a nucleus such that its nucleus become free is called binding energy.

Formula

$$BE = \Delta m c^2$$

$$BE = \left(Z m_p + (A-Z) m_n - m_{nucleus} \right) c^2$$

The curve for binding energy per nucleon is obtained by dividing the maximum nuclear binding energy by the number of nucleons.

The range of binding energy of nucleon is millions of MeV composed to tens of electron volt for atomic electron.

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Q-NO #15

What is relation b/w the binding Energy and mass number.

Answer

The equilent to mass defect is used in the nucleons and is called the binding Energy.

If Δm is the mass defect of a nucleus, Then according to Eienstien mass Energy relation

$$BE = \Delta m c^2 \text{ (in Joule)}$$

Q-NO # 16

Discuss the short note on the magnetic lens spectrometer.

Answer:-

The spectrometer Consists of a a large area, angular, segmented lithium-drifted sillicon electron detector shield from the traget by a photon sheild.

A permanent magnetic lens direct electron around the photon shield to detector.

The source sits the outside the magnetic field and is accessable through 180° to a movable detector.

Q-NO #17

Why do nuclei undergo beta decay.

Answer:-

Beta decay occurse, when, in a nucleus with to many proton or too many neutrons one of the proton or neutron is transformed into the other

In Beta minus decay, or neutron decay into the a proton an electron and anti neutrino.

Beta decay occurres, when an atom has either too many proton or too neutrons in its nucleus

$$H_1^3 \rightarrow He_2^3 + e_{-1}^0 + \bar{V}_0^0$$

Q-NO #18

Fermi theory of Beta decay short notes.

Answer:-

Interaction between nucleus, electron and neutrino will be expressed as a perturbation to the total Hamiltonian.

Decay probability expressed by matrix element

Beta decay energy E_0 divided between electron and neutrino

NOT all division are equallay probable would mean flatt Beta spectrum.

This interaction explains the beta decay by direct coupling of a neutron with an electron, a neutrino and a proton.

Election capture
Double beta decay.

Q-No #19
What is the simple explanation of gamma decay.

Answer:-
Gamma decay is the nucleus way of dropping from a higher energy level to a lower energy level through the emission of higher energy photon.
The energy level transition energy in the atom are in the order of MeV. Therefore, the gamma ray emitted is also of very high energy of the order of MeV Just like x-rays.
Gamma rays are not defeclected by electric and magnetic field.

Q-No #20
What are the Similarity between

Answer:-

Neucleus	Liquid Drop model
(i) strong force b/w nucleus	(i) Cohesive force between liquid moelecules.
(ii) Nucleas density is constant and is independent of nuclear volume.	(ii) The density of liquid in liquid drops is constant

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(iii) In radioactive decay some nucleus have enough energy to Jump out of nucleus.

(iv) Nucleus has surface energy proportional to $A^{2/3}$

(v) In stabel state nucleus is spherical in shape

(iii) When heat is supplied to a drop, it evaporates.

(iv) Liquid drop has surface tension

(v) Liquid drop is spherical in shape due to spherical symmetry of surface tension.

Q-NO #21

Discribe the limitations of liquid drop model.

Answer:

The main limitations of liquid drop model are,

(i) Neclei of all the elements are considered to behave liquid drop model of incompressible liquid of very high density.

(ii) Nuclei is spherical in shape due to strong attractive nuclear force just like spherical shape of liquid due to surface

(iii) Binding energy per nucleon of nucleus is constant just like the latent heat of vaporasation of liquid.

Q no # 22

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Two reason of Acceptance of Proton Nutron Hypothesis.

Answer:-

Finite Size:-

Since the mass of nutron is approximation equal to the mass of preton, it is possible for neutron to reside inside the nucleus.

According to the uncertainty Principle.

Isotopic mass:-

It is possible to explaine the existance of isotopic of different elements different isotopes of an element have same number of preton but different number of neutron in the neuclei.

Q-NO # 23

Describe the basic Principle of Betatron Accelerator.

Answer:-

Betatron is a type particle Accelerator and is used to accelertor electron.

It used the electric field induced by a varying magnetic field to accelerator, electron to high speed in a circular orbit. the word Betatron drive from

the fact that high energy elektron are often called β- particle.

Q-NO # 24
Contribution of pairing energy in the nucleus binding energy of a nucleus.

Answer:-

Binding energy is nessary to split subatomic particles in atomic nuclear or the nucleus of the atom into its components namely.

Neutron and protons are collectively know as the nucleus.

Q-NO # 25
Discuss the Contribution Coulumbs Law in the binding energy of Nucleus.

Answer:-

The coulumbs law energy is the repulsion between the protons. the asymmetry energy is a reduction in the binding energy which occurse when there are more neutron then proton and vice versa.

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QNO# 26
Discuss the limitation of cyclotron.
Answer:-
At High velocities:-
(i) (Radio)ˣ Relativistic variation of mass of particle upsets the reasonce condition.
(ii) cyclotron cannot accelerate uncharged particle like neutrons.
(iii) cyclotron cannot accelerate electrons because of it small mass.
(iv) cyclotron cannot accelerate positive charge (ion) particle with large mass due to relativistic effect.
(v) cyclotron is not suitable for very high kinetic energy.
(vi) cyclotron is suitable for accelerating heavy charged particle.

QNO# 27
Short Note on Nuclear parity.
Answer:-
Parity is a useful concept in both nuclear physics and Quantum mechanics.
Parity help us explain the type of stationary wave function (either symmetric and Asymmetric) That subatomic particles like neutron or proton have.
In simple words,

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parity is that reflection of coordinates about the origin

Q-No #28
What are evidences for the Shell Structure of the Nuclei.

Answer:

Evidence For Shell Structure:-

The most sensitive of these are Electron knockout reactions, where an electron comes in and an electron and proton or neutron escape, usually denoted as
(e, e', P) (e, e'n)
reactions. In those we see clear clear evidence of peaks at the single particle energies.

Q-No # 29
What are the Assumption of

Nuclear drop model | Liquid Drop model

(i) The nucleus consists of incompressible matter.
(ii) The nuclear force is identical for very nucleon
(iii) The nuclear force saturates.
(iv) In an equilibrium state, the nuclei of an atom remain spherically symmetric under the action of strong attractive nuclear forces.

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(v) The electron revolve around the nucleus in well defined orbits.

(vi) The size of the nucleus is very small as compared to the size of the atom.

Q-NO#30

What are limitation of liquid drop model.

Answer

Repeat

Q-NO#31

Discuss the Failure of liquid drop model.

Answer:-

Liquid drop model successfully explained stability of nucleus, Nuclear fission and phenomenon of radioactive nucleus and artificial radioactivity. Liquid drop model also help us the calculate the atomic masses and binding energy of the nuclei quite accurately

But liquid drop model fail to explain:

(i) High stability of nuclei with magnetic number

(ii) The measured spin and magnetic moments of the nuclei.

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Q-No# 32

A particle which produced ionization is less pentrating why.

Answer:- A particle which produced ionization is less pentrating

Reason:-

Because of the large mass of the alpha particle, it has the highest ionization power and the greatest ability to damage tissue. That same large size of alpha particle.

However, makes them less able to penetrate matter.

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Past Papers

Long Questions

Q-NO#01

Explain the Concept of nuclear electric quadrupole moment

Q-NO#02

By using semi empirical formula, find an expression for the atomic number of the stable nuclei after β-decay.

Q-NO#03

Discuss the multipolarities of x-rays.

Q-NO#04

How limitation of nuclear Shell model were rectified by collective nuclear model. Also give achivements of collective nuclear model.

Q-NO #05

Explain the theory of gamma decay in detail by explanation multi polarity of gamma decay.

Q-NO #06

High light the achievement and failure of liquid drops model Also give Similarities between nucleus and liquid drop model.

Q-NO #07

What are different modes of β decay? Explain with the help of nuclear equations.

Q-NO #08

Briefly describe theory of Spontaneous alpha emission.

Q-NO # 09

Explain the classical concept of quadrapole moment of nucleus

$$-\frac{\hbar^2}{m}\frac{d^2y}{dx^2} + V(x)U(x) = E(x)U(x)$$

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Q-NO#10

write down the detail ~~not~~ nuclear magnetic dipole moment.

Q-NO#11

Obtain the expression for binding energy of a nucleus bassed on liquid drop model.

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